UTAH DEPARTMENT OF TRANSPORTATION

TECHNICAL BULLETIN MT

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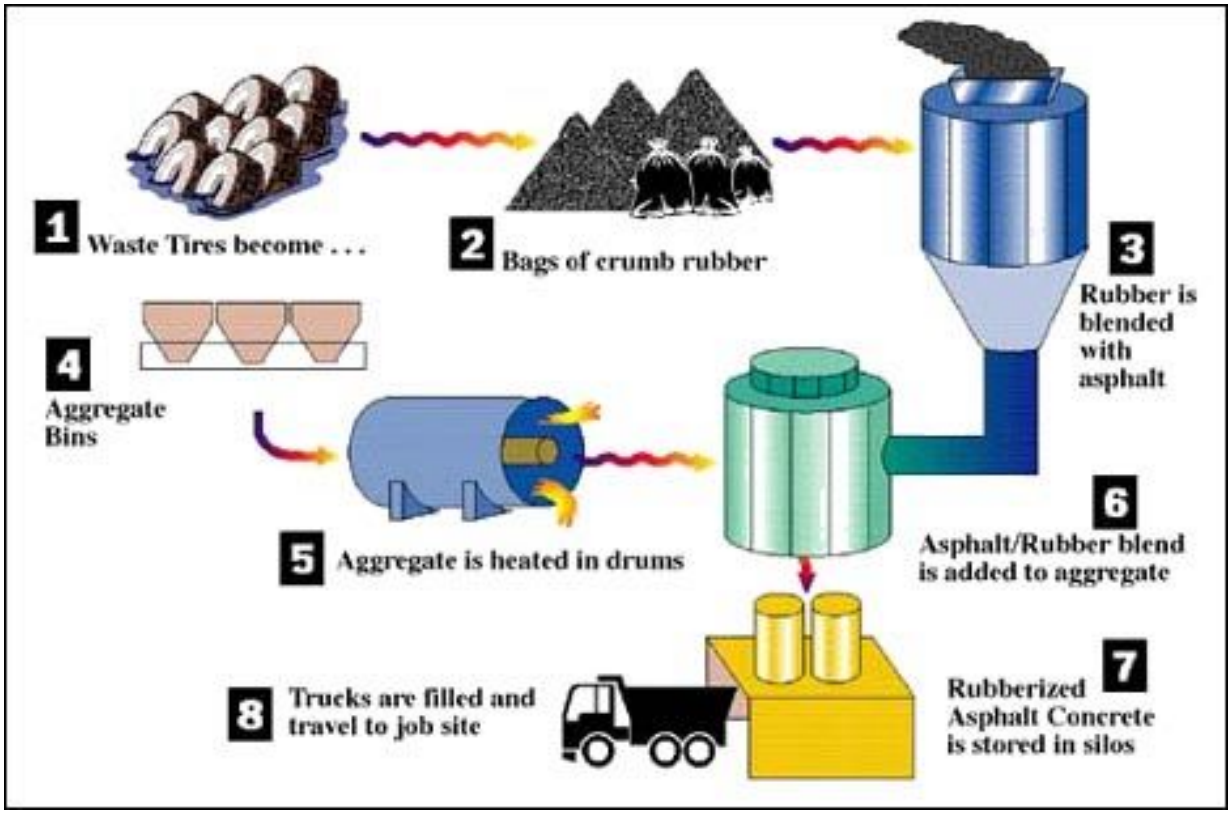

Crumb Rubber "Wet" Process

RUBBERIZED ASPHALT

The concept of using Rubberized Asphalt in paving materials comes in two forms: 1) crumb rubber, used as an aggregate in the aggregate matrix and 2) processed rubber, used in the asphalt cement binder know as Terminal Blend. Crumb rubber asphalt mixes have been used for over 20 years and are based on using a gap-graded mix of aggregate, and incorporating the ground rubber into the mix prior to adding the asphalt binder. Terminal blend mixes are a more recent approach based on new technology that allows for better incorporation of the crumb rubber into the asphalt binder.

WHAT IS IT?

Crumb rubber mixes (known as asphalt rubber mixes) are based on the incorporation of a sand-grain size ground rubber into a typical paving hot mix asphalt (HMA). The rubber is introduced into a gap-graded mix either through blending it with the asphalt binder (wet process) or with the aggregate prior to the addition of the asphalt binder (dry process). The elastic properties of the crumb rubber are utilized by the asphalt rubber (AR) mix, creating a viscoelastic matrix. This creates a mix that is more flexible than a current HMA, which reduces the permanent damage in the pavement as it carries loads. The highly elastic properties of the rubber allow the mix to return to its original position better than PG mixes. The average percent binder for an asphalt rubber mix is 6% to 7% AC and 2% to 3% rubber.

Terminal blend mixes are created by de-vulcanizing the crumb rubber and digesting it into the binder. The modified binder is then incorporated into a paving mix the same way that current PG binders are. The intent of this process is to give the asphalt binder some of the elastic properties taken from the broken down rubber. This significant increase in the binder's elastic properties is similar to the benefits received through the introduction of elastic polymers currently used in Polymer Modified Performance Grade (PG) binders. The average percent binder for terminal blend is similar to PG mixes, around 5% based on the denseness of the gradation. Terminal blend materials can be, and usually are, specified using the PG grading system, with the majority of the terminal blend rubberized asphalts graded as PG 70- 28s or PG 76-28s. This is due partly to the higher temperatures of the current geographic locations using these binders, Texas and Arizona, and the typical range of properties gained by incorporating the rubber. Typical rubber contents are around 9% rubber, by weight of the virgin binder.

WHAT CAN IT DO?

Performance of the Asphalt Rubber mixes is equal to or better than PG binders in a structural setting. The benefit of a highly visco-elastic material is gained in supporting and carrying repeated loads. The material is more capable of flexing and returning to its original configuration, minimizing the accumulation of damage. A second benefit, and sometimes significant one is the potential for noise reduction. When used as a friction course on the surface of a pavement, the Asphalt Rubber mix can reduce noise in the range of 6 to 10 decibels over transverse tined concrete. This reduction will be less if the pavement is tined longitudinally. The audible range for change in decibels is 3 to 4 decibels and the benefit of an AR friction course has been compared to the current pavement condition. A third and minor benefit is that the incorporation of rubber into a pavement can be considered a way to reduce tire population. The benefit is only realized by states that have a Crumb Rubber Tire Recycling plant.

LIMITATIONS IN UTAH

There are several construction limitations which can lead to premature failures. Construction temperatures are critical, with the requirement of 70°F and rising for pavement and ambient temperatures. Paving must also stop in high temperatures (>100°F) to allow for proper construction. The paving season in Utah would be limited to late spring and early fall. Dense-graded Asphalt Rubber layers are not sufficiently stable to be placed greater than 2½ inches thick, and must have solid (bound) paving surface underneath. Currently the long-term performance (durability) in cold-weather and freeze-thaw environments is suspect. There are not many ARDG or ARFC layers placed in freezethaw

settings that can be reviewed. The potential for crack mitigation is there, however, the potential for de-bonding and raveling also exists.

The structural durability of a terminal blend rubberized asphalt is significantly greater than that of a neat (unmodified) asphalt. It is marginally different than that of a well constructed polymer modified PG Binder mix. Utah currently uses about 98% modified binders in its HMA pavements. The costs for rubberized asphalt mixed are approximately double that of a neat AC and about 30% to 50% more than a polymer modified mix. While the terminal blend mixes are high quality mixes, similar if not better than Superpave, the price may be exclusive. Hamburg Wheel Tracker test results show good performance of a terminal blend mix, however, not significantly different than a high-polymer content modified PG mix. The benefits gained do not currently support the expected costs. Life-cycle analyses show the AR mixes last longer, but cost more on annual breakdown.

Additional Points of Interest:

- Initial recommendations are that it can be a good product as a terminal blend, however it should compete with a PG grade oil as opposed to being specified alone. So far in Utah crumb rubber has not been economical or able to compete with SBS polymer at the terminal. It takes 3 to 4 times more GTR to have the same effect as SBS polymer.
- The use of Rubberized Asphalt has become a political football in Arizona, for noise-reduction only. Arizona has experimented with Terminal blend type applications in some of the higher load roadways, however, they do not use PMAs and this is their approach to using a modified asphalt.
- Importing material from Arizona will moot the main demonstrated political benefit of eliminating waste tires.
- Crumb Rubber Rubberized Asphalts have been used successfully in Sacramento County, South Carolina, Nebraska and British Columbia.
- Terminal Blend Rubberized Asphalt have been used primarily in Texas, both as a dense-graded HMA and a chip seal oil.
- There are two distinct suppliers of terminal blend the southwestern US: Wright Asphalt and a smaller company.
- Liberty Tire is a crumb rubber supplier in Salt Lake City. There are approximately 4 other crumb rubber tire plants in the surrounding states.
- Cement Plants compete in Utah for used tire disposal. The plant gets the disposal fee incentive and the tires are an excellent source of heat for the kilns.

Further Direction:

- UDOT needs to research the elastic modulus of the material and see if there are additional unidentified benefits.

Further Information:

- Dr. Julie Nodes, P.E., Asphalt Engineer, Arizona DOT, 602-712-8150

- George Way, P.E., Asphalt Engineer, Arizona DOT, 602-712-8085
- Report on the Status of Rubberized Asphalt Traffic Noise Reduction in Sacramento County, Bollard and Brennan, Inc., November 1999.
- The Full Scale Evaluation of Rubberized Asphalt Concrete in British Columbia, Infratech Polymers Inc., 1995.
- Utilization of Crumb Rubber in Asphaltic Concrete Mixtures – South Carolina's Experience, Amirkhanian, Serji N., Department of Civil Engineering, Clemson University, January 2001.
- http://www.rubberizedasphalt.org

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